5.9 GHZ DSRC CONNECTED VEHICLES FOR INTELLIGENT TRANSPORTATION SYSTEMS

AUTO ALLIANCE

DRIVING INNOVATION®

GlobalAutomakers

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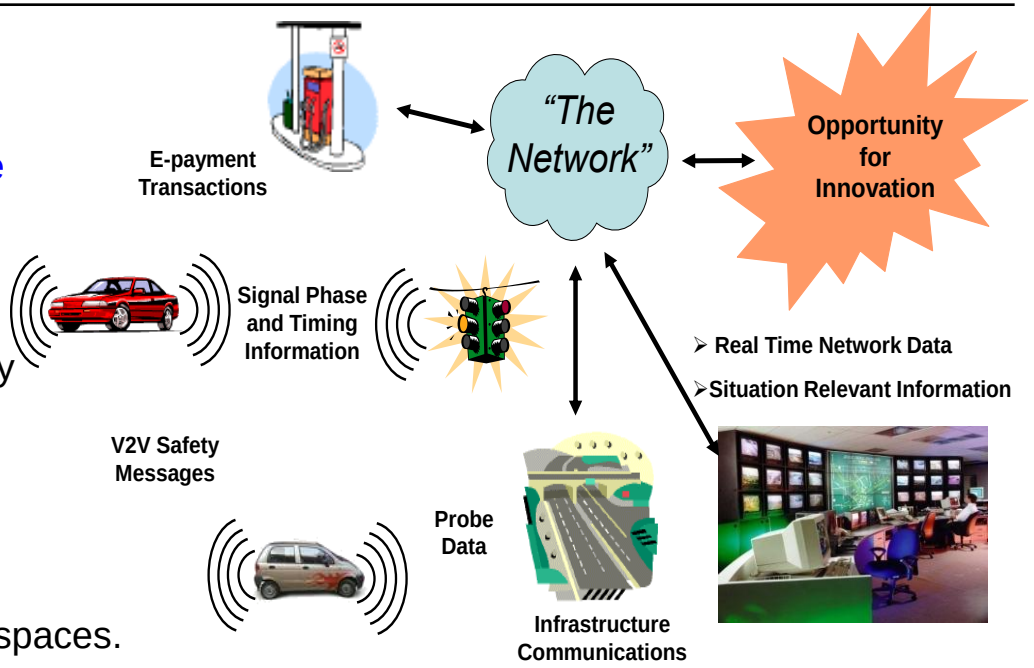
INTRODUCTION TO DSRC

- Congress created the Intelligent Transportation System (ITS) program in 1991.
- Administered by USDOT.
- Uses advanced electronics to improve vehicle safety, decrease traffic congestion, reduce air pollution, and conserve fossil fuels.
- Dedicated short-range communications (DSRC) is a wireless (IEEE 802.11) ITS system designed for automotive use.
- DSRC is a short-to-medium-range wireless communication protocol that permits very low latency data transfers that are critical in communications-based active safety applications.

VEHICLE-TO-VEHICLE / VEHICLE-TO-INFRASTRUCTURE OVERVIEW

Vehicle-to-Vehicle / Vehicle-to-Infrastructure (V2X):

- Uses advanced Wi-Fi (Dedicated Short Range Communication) and GPS to enable wireless communication between vehicles and with infrastructure.
- Intelligent vehicles send real-time data to notify drivers of potential collision threats, communicate road hazards or congestion to data centers, enable alternative traffic routing, and provide the driver with key information to maximize mobility, such as smart parking that locates and directs the driver to open parking spaces.



- NHTSA estimates that vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) technologies have the potential to address over 80% of the light vehicle target crash scenarios involving unimpaired drivers, including intersection collisions that are currently not addressed.
- With over 500 million vehicles in operation in the U.S. and Europe, the V2X network would be similar in size to the number of members on Facebook™.

V2X technology could enhance existing obstacle detection-based driver assistance systems and help optimize the transportation network.

DSRC = OPPORTUNITY FOR SAFER DRIVING

Vehicle crashes account for:

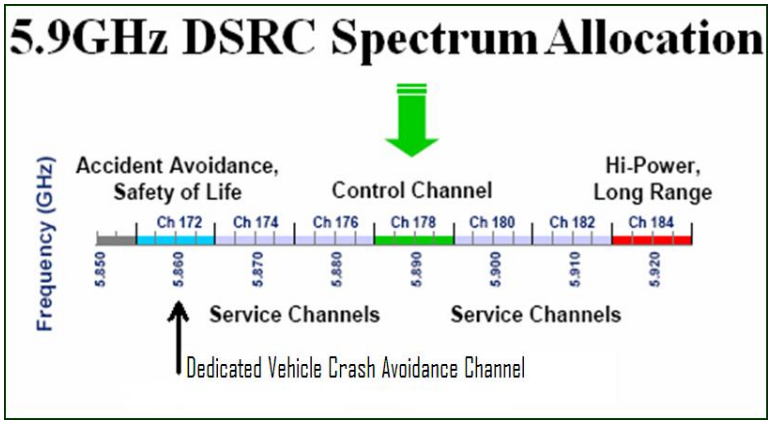
32,367 deaths/year (2011)
5,338,000 crashes/year
leading cause of death for ages 4-34

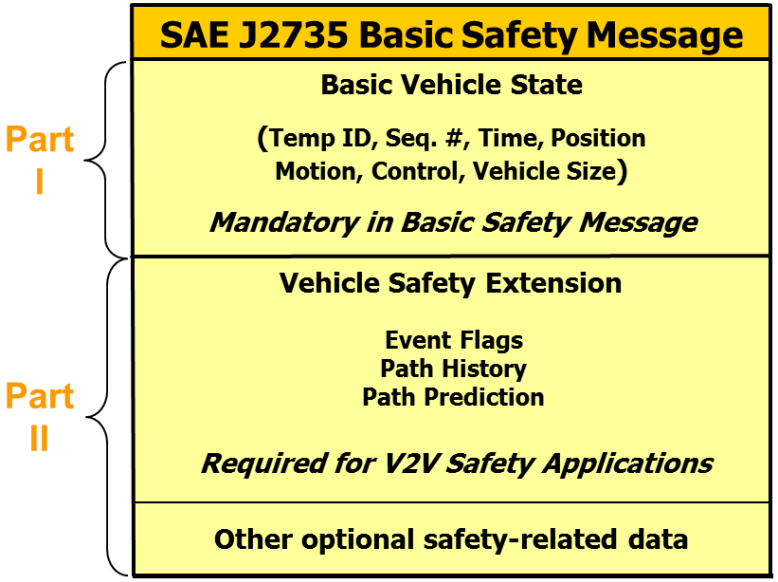
- Greater situational awareness
  - Your vehicle can “see” nearby vehicles and knows roadway conditions (e.g., road works) you can’t see
  - 360 degree “visibility”

- Reduces or even eliminates crashes thru:
  - Driver Advisories
  - Driver Warnings
  - Vehicle Control

Dedicated Short Range Communications (DSRC)

- 75 MHz of spectrum @ 5.9 GHz for ITS
- Key Benefits
  - 802.11p technology similar to 802.11a
  - Low latency communication (<< 50 ms)
  - High data transfer rates (3 – 27 Mbps)
  - Line-of-sight, up to 1000 m and 360º
  - Low power message reception (< -90 dBm)

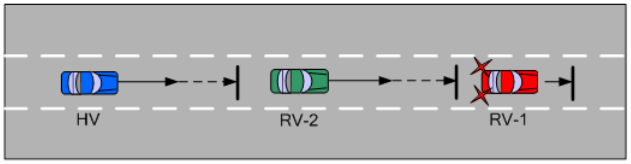




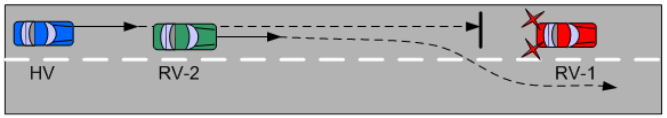
- Standards
  - IEEE: 802.11p, 1609.2 – 1609.4, 1609.12
  - SAE: J2735, J2945
- V2V Basic Safety Message (BSM)
  - Average message size: 320 bytes
    - PHY + MAC + WSMP: 80 bytes
    - Security including Certificate: 160 bytes
    - SAE J2735 BSM payload: 80 bytes
  - Default transmit rate: 10 Hz
    - More sophisticated protocols in development
  - Enables multiple V2V Safety Applications

V2V Safety Communications – Summary

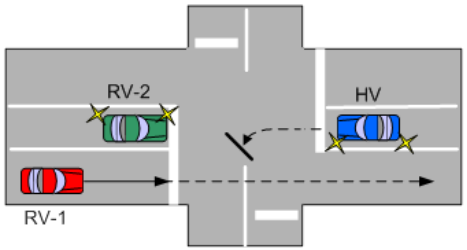
- Different manufacturers
- Communicating on the same channel
- Exchanging the same BSM information
- Enables multiple V2V safety applications



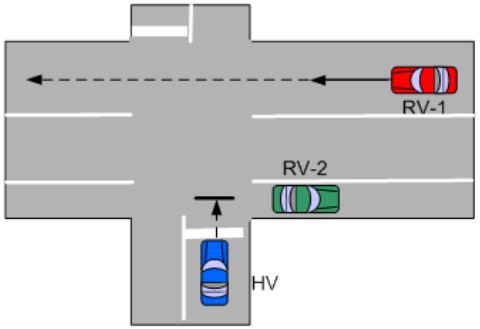
Emergency Electronic Brake Lights (EEBL)



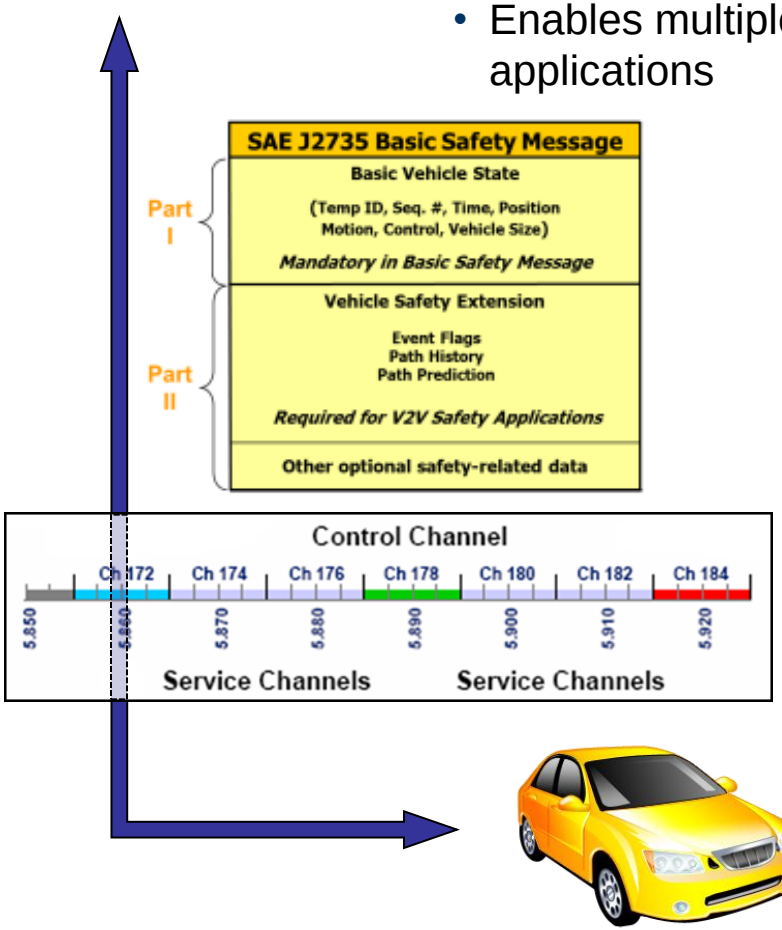
Forward Collision Warning (FCW)

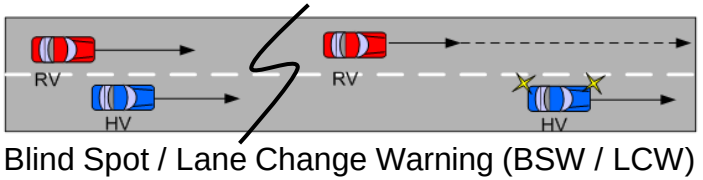


Left Turn Assist (LTA)

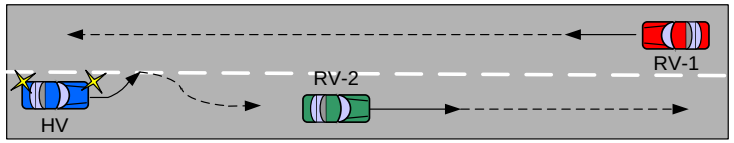


Intersection Movement Assist (IMA)





Blind Spot / Lane Change Warning (BSW / LCW)



Do Not Pass Warning (DNPW)

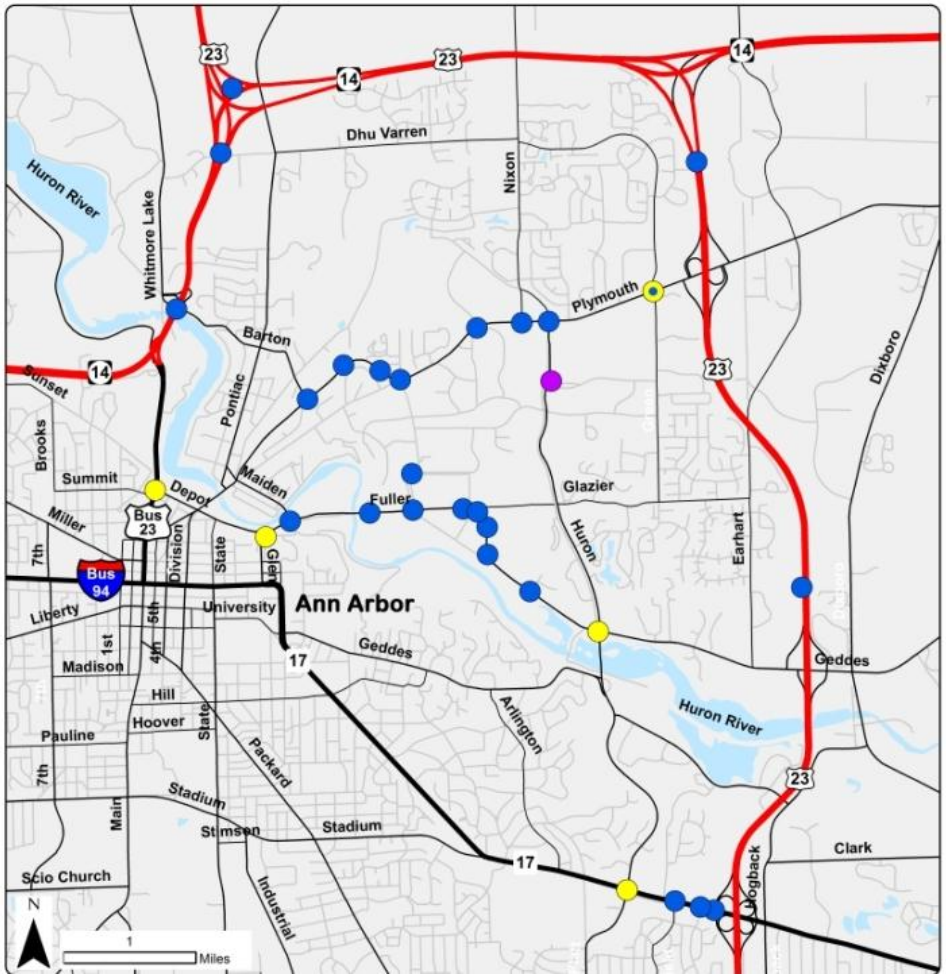
USER ACCEPTANCE – DRIVER CLINICS

- 6 locations across the U.S. – began in August 2011
- Over 100 drivers per location
- Utilizing driver warnings
  - Emergency Electronic Brake Lights
  - Forward Collision Warning
  - Left Turn Assist
  - Intersection Movement Assist
  - Blind Spot Warning
  - Lane Change Warning
  - Do Not Pass Warning
- Feedback from drivers was overwhelmingly positive
  - ~90% of drivers expressed desire for such a system

MODEL DEPLOYMENT SITE – ANN ARBOR, MI

Key Site Elements:

- 75 miles of instrumented roadway
  - 27 roadside units
- ~3000 vehicles
  - Cars, trucks, buses
  - Integrated, aftermarket, and retrofit
- 1 year of data collection



KEY SAFETY PROGRAM OBJECTIVES

- 2013 NHTSA Decision on Vehicle Communications for Safety (light vehicles)
- 2014 NHTSA Decision on Vehicle Communications for Safety (heavy vehicles)
- 2015 FHWA Infrastructure Implementation Guidance

HARMFUL INTERFERENCE TO 5.9 GHZ DSRC CONNECTED VEHICLE SAFETY

- *"Harmful Interference" includes any* ***"interference which endangers the functioning of"*** *DSRC safety services, due to the fact that the opportunity for DSRC to potentially prevent a collision would be impaired. (47 C.F.R.* § 2.1)

- Interference should not lead to the delay or omission of a timely safety action (e.g., warning information or control actions provided to the driver/vehicle) that could have otherwise been provided in order to prevent a crash.

- The threat of an imminent crash could arise instantaneously during driving conflicts. Therefore, any delay in timely warning or control actions caused by interference must be imperceptible.

V2X SAFETY AND AUTOMATION APPLICATIONS MUST BE FREE FROM HARMFUL INTERFERENCE

- OEMs and NHTSA have focused on V2V Crash-Imminent Warnings. In the Model Deployment, Basic Safety Messages are on one DSRC channel, service announcements on another channel, and services on several others. NHTSA's 2013 regulatory decision will address the subject.
- Additional applications which require low-latency communications will use other DSRC channels. A sample channel plan is shown on the next slide.
- For example, NHTSA recent guidance on automated vehicles states:
  - Automated vehicles may use on-board sensors, cameras, GPS, and telecommunications to obtain information in order to make their own judgments regarding safety-critical situations and act appropriately by effectuating control at some level. In fact, he realization of the full potential benefits and broad-scale implementation of the highest level of automation may conceivably rely on V2V technology as an important input to ensure that the vehicle has full awareness of its surroundings.

Illustrative DSRC Channel Plan

- Ch 172 -Vehicle-to-Vehicle: Crash Avoidance Safety *
- Ch 174 – Vehicle-to-Vehicle: Autonomous Vehicle and Pre-Crash
- Ch 176 - Vehicle-to-Infrastructure: RSU for Heavy Traffic and Multi-Lane Highway Automation
- Ch 178 - Central Control Channel *
- Ch 180 – Vehicle-to-Infrastructure: Security Communications (Anti-Hacking)
- Ch 182 - Vehicle-to-Infrastructure: Work Zone Safety, Tolling, Road Condition Warnings, Driver Assistance, Commercial Uses, etc.
- Ch 184 - Vehicle-to-Infrastructure: Public Safety Agencies, State Highway Agencies, etc. (Intersection Safety, Emergency Vehicle Signal Priority) *

*- Use restriction designated in FCC rules

STRONG USDOT SUPPORT AT ALL LEVELS

"This research should bring us a step closer to what could be the next major safety breakthrough."

- Former U.S. Transportation Secretary Ray LaHood

"With its potential to save lives and prevent injuries, connected vehicle technology could be a real game-changer for vehicle safety."

- NHTSA Administrator David Strickland

"The past several decades of auto safety have been dedicated to surviving crashes, but the future will be about avoiding crashes. That is what connected vehicles are all about."

- RITA Acting Administrator Greg Winfree

SUMMARY

- 5.9 GHz DSRC is essential for V2V crash-imminent safety applications, and must be protected from U-NII-3 and U-NII-4 devices.
- V2V safety has stringent communications requirements, but future pre-crash and automation requirements may be even more stringent.
- All current DSRC channels are needed for future applications and re-channelization and channel use rule changes are not feasible.
- Currently in final stages of U.S. DOT NHTSA mandate decision.
- Thorough testing is needed to determine U-NII device sharing constraints and appropriate requirements.